

Household pollutants disrupting fish genes

Scientists have long known that some "endocrine-disrupting" chemicals in the environment disturb normal sexual reproduction and development in animals. A new study shows that the impact appears to be greater in fish, which are susceptible to damage from many more common household pollutants than previously thought.

Researchers from the University of Maryland Biotechnology Institute and its Center of Marine Biotechnology said the increased vulnerability is related to unique physiological mechanisms in the hormone production system of fish.

As a result, harmful compounds in human pollutants interact directly with sex genes in the brain of fish rather than with estrogen receptors in other tissues, the researchers explained.

The results were reported recently at the annual meeting of the Society for the Study of Reproduction in Baltimore.

The findings, the scientists warned, have serious implications for the sexual reproduction and development of fish populations in the Chesapeake Bay (and presumably other bodies of water), where surging development in the region is leading to increased discharge of polluting compounds from millions of homes, gardens, and garages.

A study showing that many common household chemicals hurt sexual reproduction and development in fish is troubling news for the Chesapeake Bay and other waters near heavy urban development.

With thousands of miles of shoreline and an average depth of less than 30 feet, the Chesapeake Bay is considered a prime habitat for fish spawning and hatching.

"I would not say that [the problem] is severe enough that any population is becoming completely mono-sexed," said John Trant, an associate professor at the Center for Marine Biotechnology in Baltimore. "However, because the Bay is so important as a nursery, chemical-induced perturbations of the reproductive and developmental processes could lead to severe consequences."



Common household chemicals hurt sexual reproduction and development in fish

Environment

Chemical "Disrupters"

The research findings were based on two and a half years of lab experiments at the Center of Marine Biotechnology. The scientists found that compounds in a wide range of detergents, plastics, pesticides, medicines, and even thalates (responsible for "new car smell") disrupted the sexual development of juvenile zebra fish.

All of the environmental pollutants were tested at concentrations that can be found in the Chesapeake Bay system.

The scientists discovered that many more classes of environmental chemicals than suspected are functioning as endocrine-disrupting chemicals, and these chemicals are interacting directly with genes that are critical for reproductive success.

Unlike most animals, many fish produce two forms of a gene responsible for the enzyme aromatase, which in turn makes estrogen. One form of aromatase is in the ovaries; the other is in the brain.

The study results suggest that direct chemical disruption of the brain aromatase gene, which directly affects production of brain estrogen, may be a key mechanism behind the endocrine-related disturbance of normal

reproduction and development in fish.

The researchers first found that the differential expression of the brain aromatase gene was associated with sex differentiation. "It became clear that compounds that affect this gene will thereby affect sex and sexual behavior in fish," said Trant.

In other words, the researchers found that the endocrine-disrupting compounds can regulate the aromatase gene in the brain, affecting more than a fish's sex. "What is dangerous is that in-between stuff," said Trant. "You might get males who do not display the correct behavior. In order to mate with a female, he may have to court her, build a nest, chase, or show some dominance. So, even if the concentration of these disrupting compounds in the water are not sufficient to completely reverse their sexual physiology, small adjustments in their behaviors would be equally fruitless."

Broader Implications

A growing number of scientists theorise that endocrine-disrupting compounds in the water behave chemically like hormones in fish tissues and cells. When compounds such as polychlorinated biphenyls, dioxins, certain plasticisers, and some detergent

additives are in streams or rivers, groups of fish, birds, frogs, and other animals are sometimes found to be all male, or all female, or are partially both sexes in their genitalia.

Historically, scientists have suspected actual estrogens or chemicals that mimic estrogens in pollution as the causes of the "gender-bending" effects on fish.

Estrogen (or estrogen-like) molecules dock onto a structure called an estrogen receptor in the cells of the liver, ovaries, fat, breast, brain, bone, and many other target tissues in man.

The activated receptor initiates a series of changes into action related to sexual physiology. Many of the pollutants, such as PCB's, some pesticides, and petroleum products in the Chesapeake waters, are recognised as estrogen molecules by fish and human cells. "That's why scientists have focused there," said Trant. "But, this is worse than we thought before. This is not simply toxicology. It is interfering with the reproduction of the adults, and potentially skewing sex ratios of the populations."

The research team reported that the aromatase gene expression in zebrafish was changed by multiple classes of pollutants such as estrogen mimics (or xenoestrogens, such as surfactants in detergents and pharmaceuticals), arylhydrocarbons (PAH's and benzo(a)pyrene), peroxisome proliferators (pharmaceuticals and plasticisers), and herbicides (atrazine).

"For people looking for a magic bullet of why productivity of the Chesapeake Bay is down, this is not it," said Trant. "There are probably many causes. But this is certainly affecting the reproductive health of animals that spawn here and the developmental health of animals that are raised in the Chesapeake Bay." Scientists have just been looking too narrowly at estrogen mimics, said the researchers.

They added that it's almost certain that the multiple compounds are affecting all the fish in the Bay and beyond, not just zebrafish in the laboratory.

(National Geographic)